(12) UK Patent Application (19) GB (11) 2 294 181 (13) A

(43) Date of A Publication 17.04.1996

(21) Application No 9420002.9

(22) Date of Filing 04.10.1994

(51) INT CL[6]
H04Q 7/38 7/36

(52) UK CL (Edition O )
H4L LDSH L1H10 L41T

(56) Documents Cited
GB 2242806 A EP 0589279 A2 WO 93/19560 A1

(58) Field of Search
UK CL (Edition M ) H4K KY4D14H KY4D14Q KY4D8 , H4L LDSD LDSX
INT CL[5] H04Q 7/04
Online databases: WPI

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# (54) Handover in a multilayer cellular radio system

(57) When a network requires a mobile station 19 to handover from a microcell 11 to a macrocell 1, a false BA list (neighbouring cell list) is sent to the mobile after the handover, the list only containing base station channels of the macrocells so that the mobile will then only scan signals from macrocells when seeking a new handover candidate, whereby it will remain on the macrocell layer.

To handover a mobile 18 from a macrocell 1 to a microcell 10, if the base station of the present macrocell is coordinated with the microcell layer (eg. has the same BSC), a false BA list is sent to the mobile, which list includes microcell base station channels so that the mobile scans for base stations in both the macrocell and microcell layers and may select a microcell for handover if that is the strongest. If the present macrocell base station is not coordinated with the microcell layer, a special or modified BA list is periodically sent to the mobile, which list includes microcell base station channels. The mobile will then scan the microcell layer at these times and can be retained on the microcell layer once selected.

Fast moving vehicular subscribers 19 may thus be induced to move to and then stay on the macrocell layer, and slow moving pedestrian subscribers 18 may move to and stay on the microcell layer.

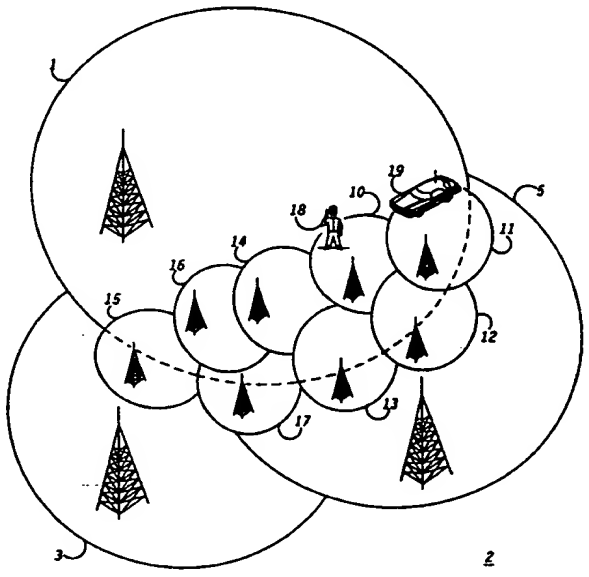


FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

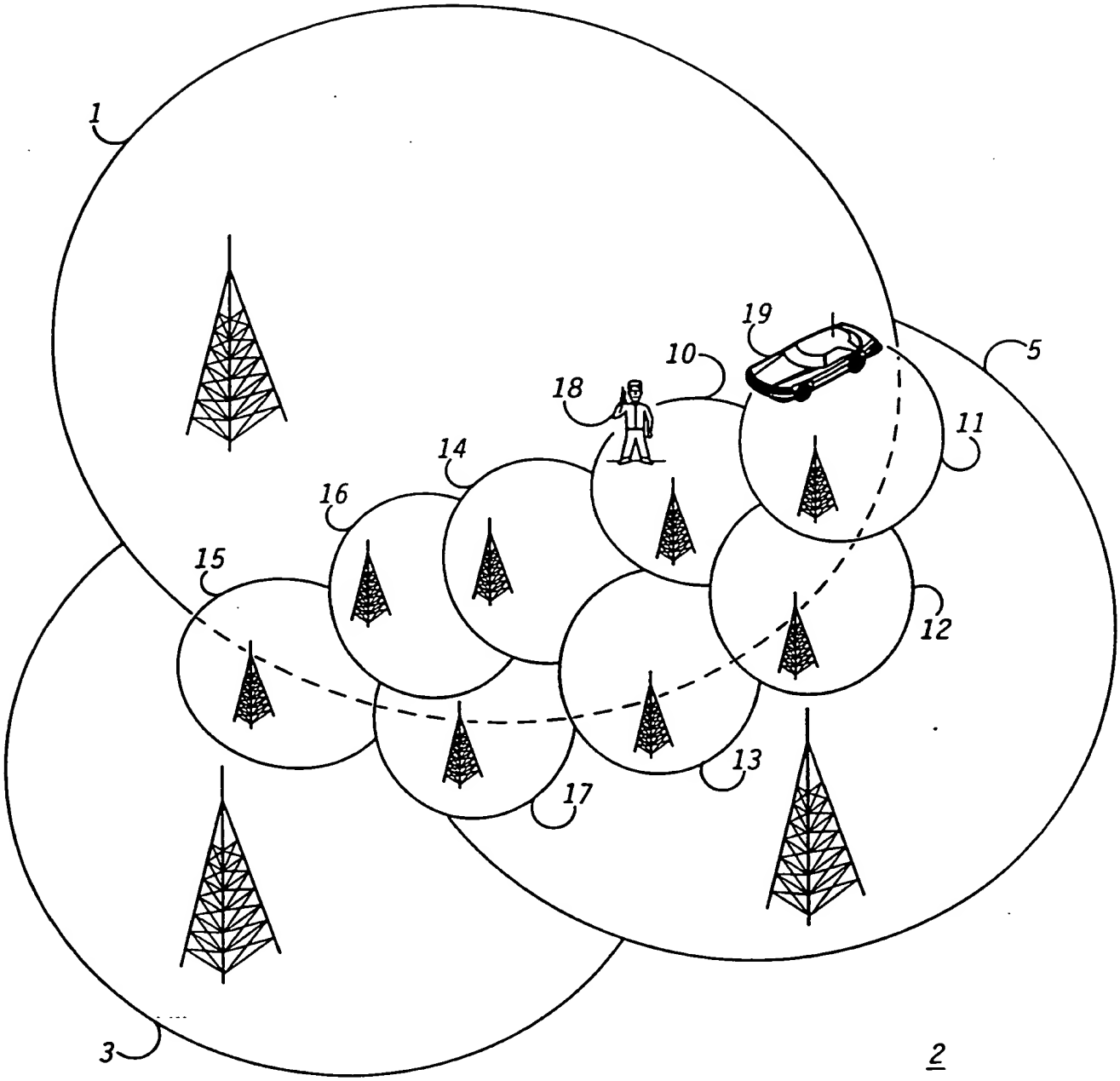


FIG. 1

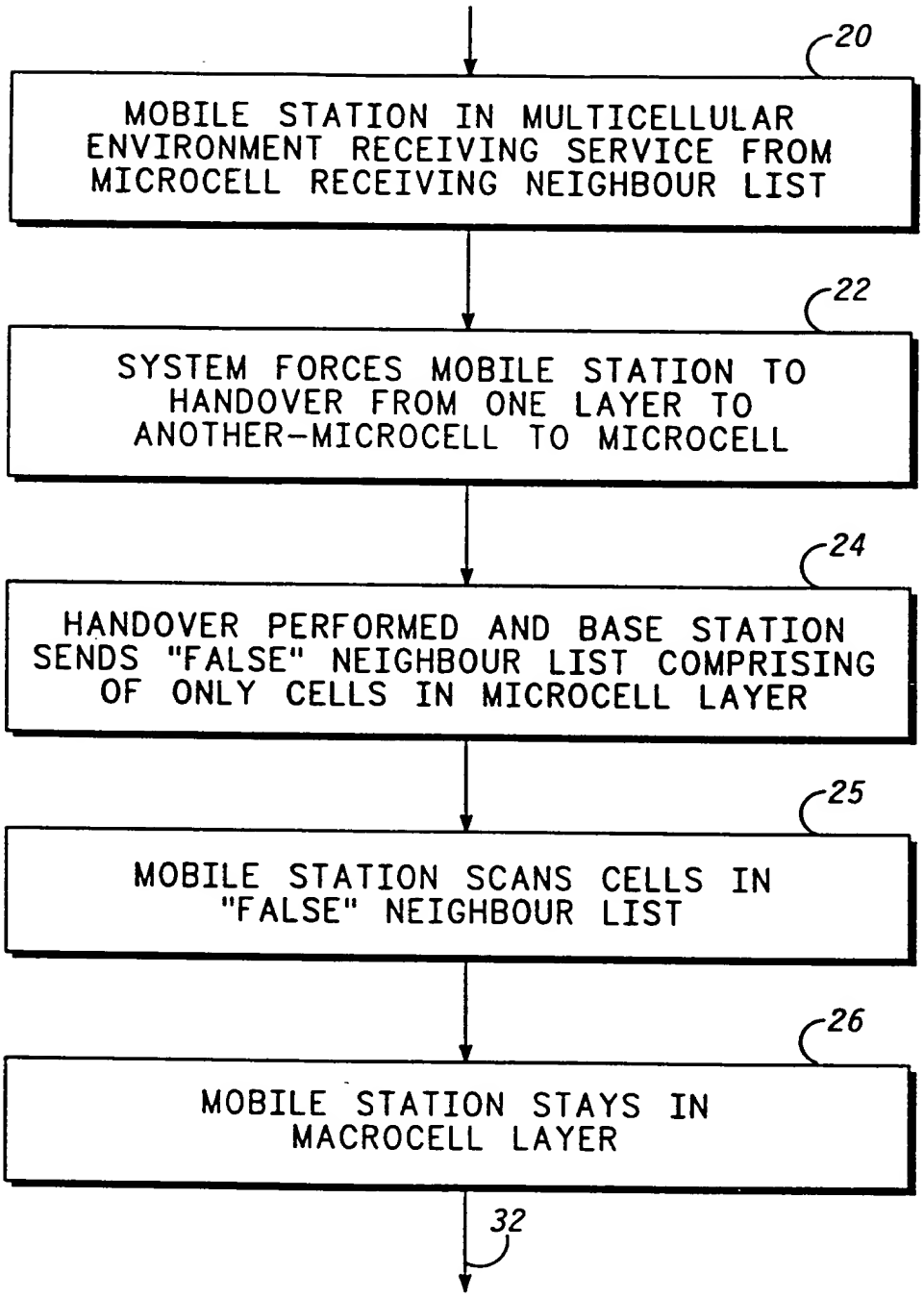
20
MOBILE STATION IN MULTICELLULAR ENVIRONMENT RECEIVING SERVICE FROM MICROCELL RECEIVING NEIGHBOUR LIST
22
SYSTEM FORCES MOBILE STATION TO HANDOVER FROM ONE LAYER TO ANOTHER-MICROCELL TO MICROCELL
24
HANDOVER PERFORMED AND BASE STATION SENDS "FALSE" NEIGHBOUR LIST COMPRISING OF ONLY CELLS IN MICROCELL LAYER
25
MOBILE STATION SCANS CELLS IN "FALSE" NEIGHBOUR LIST
26
MOBILE STATION STAYS IN MACROCELL LAYER
32

FIG. 2

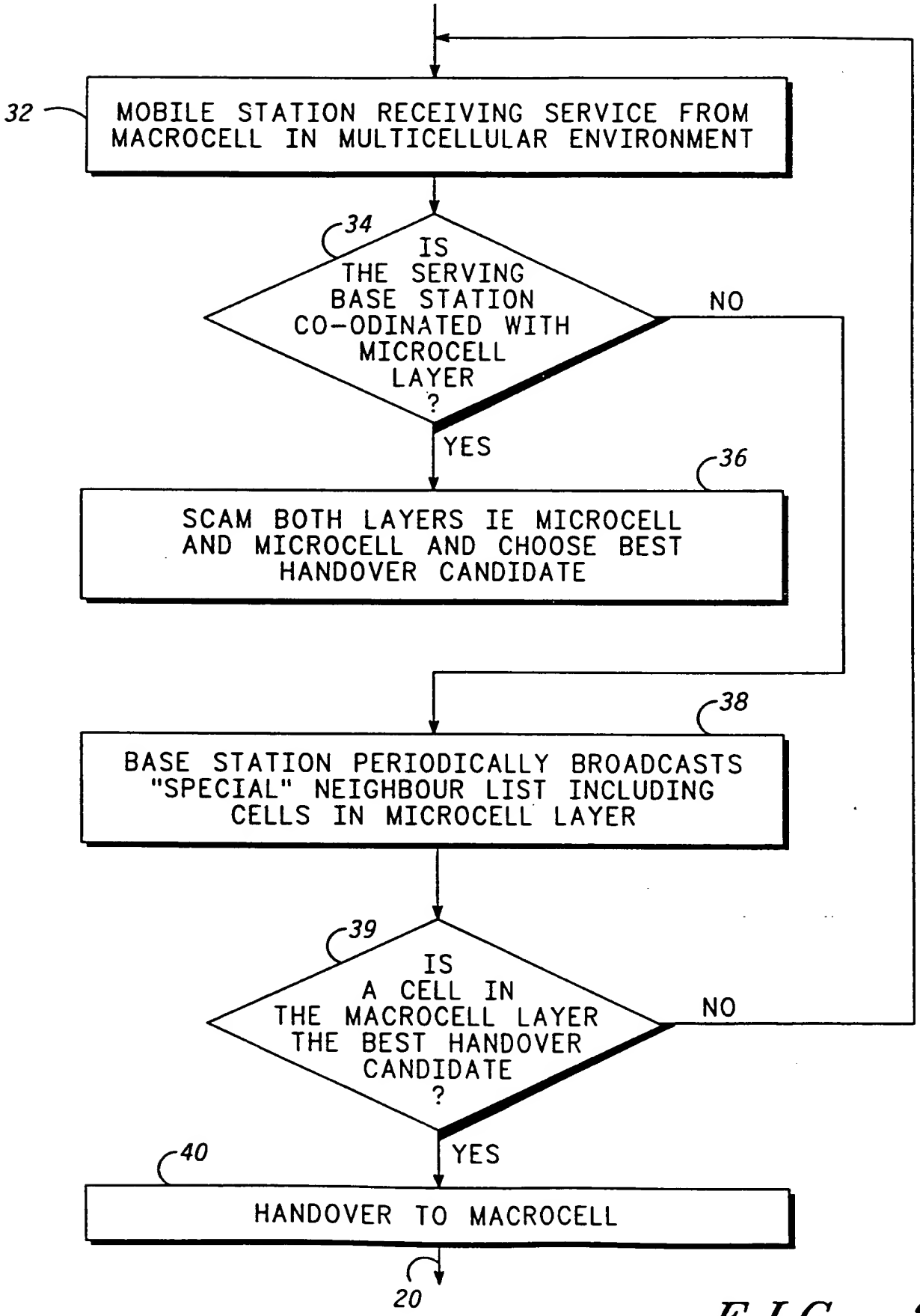
32
MOBILE STATION RECEIVING SERVICE FROM MACROCELL IN MULTICELLULAR ENVIRONMENT
34
IS THE SERVING BASE STATION CO-ODINATED WITH MICROCELL LAYER ?
NO
YES
36
SCAM BOTH LAYERS IE MICROCELL AND MICROCELL AND CHOOSE BEST HANDOVER CANDIDATE
38
BASE STATION PERIODICALLY BROADCASTS "SPECIAL" NEIGHBOUR LIST INCLUDING CELLS IN MICROCELL LAYER
39
IS A CELL IN THE MACROCELL LAYER THE BEST HANDOVER CANDIDATE ?
NO
YES
40
HANDOVER TO MACROCELL
20

FIG. 3

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# METHOD FOR HANDOVER IN MULTICELLULAR ENVIRONMENT

## Field of the Invention

This invention relates in general to a communications system in a multicellular environment, and more particularly to a method for handover in a multicellular environment including an overlay and underlay of macrocells and microcells.

## Background to the Invention

In a cellular communications system, a service coverage area by a base station is called a cell. In a multicellular or macrocellular environment, a larger cell, or macrocell, may be further divided into smaller cells, or microcells in order to increase capacity. An overlay of macrocells may be implemented over the same area that an underlay of microcells are implemented. Thus, a microcellular network includes a plurality of microcells which may be partially disposed within at least one macrocell. A mobile station may be located in an area that is serviced by both a macrocell and a microcell.

In some cellular communications systems it is sometimes desirable to have more than one layer of cells. A particular example is a layer of microcells (e.g. a cluster of small cells a few hundred metres in diameter or less) existing under an "Umbrella" of a much larger cell or cells, usually known as macrocells. Other examples might include (not exclusively) concentric cells where an area of coverage is divided into an inner region near to the base station site and an outer annular region further from the base site, with each region treated as separate cells. A further example is that of conventional cells versus " Supercells" where "Supercells" in GSM (Global System for Mobile Communications), terminology means cells which include coverage of communications ranges in excess of 35Km from the base station, often used for rural or maritime coverage. Another term for this is "Extended Cells".

Having established a multi layer cellular network, it is often necessary to direct certain mobile stations (or subscriber units) from one layer to another layer and to hold a mobile station in one layer or the other. It may further be desirable to accomplish this, even though the normal cell

selection procedure would result in the mobile naturally selecting a cell layer other than the one desired by the revised system operation. A particular example is in microcell/macrocell networks, where it is desirable to direct fast moving vehicular subscribers to a wide area macrocell network and slow moving pedestrian subscribers to a small area microcell network. In such communications systems, there may be no mechanism in the network to do this as part of normal systems operation. A particular example is the GSM phase one networks, which did not anticipate microcellular operation and in which all mobile subscribers (fast moving and slow moving) select the strongest cell (which would usually be the nearest microcell).

Thus, it is desired to have a method to induce a mobile station to select the cell layer preferred for system operation and to maintain the mobile on that layer as required.

## Summary of the Invention

According to the present invention, there is provided a method of performing a handover for a mobile station in a multicellular environment including the steps of determining to handover from one of a plurality of microcells to a macrocell, performing handover from the one of the plurality of microcells to the macrocell, and sending a false neighbour list to the mobile station.

In an alternative embodiment of the present invention a method is provided for periodically broadcasting a modified neighbour list that includes cells that are associated with the layer that the mobile station is not currently receiving service from.

## Brief Description of the Drawing

FIG. 1 illustrates a multicellular environment.

FIG. 2 is a flow chart for a method for preferred embodiment of the present invention.

FIG. 3 is a flow chart for a method for an alternative embodiment of the present invention.

## Detailed Description of the Preferred Embodiment

Referring to FIG. 1, a multicellular environment is shown 2 having at least one macrocell 1 wherein partially disposed in the macrocell 1 is a

plurality of microcells 10-17. Each cell has a respective base station for communications with at least one mobile station. A fast moving mobile station 19 is shown being serviced by a macrocell 1 and a slow moving mobile station 18 is shown being serviced by a microcell 10.

In FIG. 1, may be further defined as showing a multicellular environment having at least one overlay layer including a plurality of macrocells 1, 3, 5 and an underlay layer including a plurality of microcells 10-17, the underlay layer of microcells is at least partially disposed within the overlay layer.

FIG. 2 shows a method for performing a handover in the multicellular environment of FIG. 1. The method of the present invention includes inducing a mobile station to select a particular cell layer preferred for system operation and to maintain the mobile station on that layer as required.

A GSM mobile station while in idle mode (waiting to make or receive a call) will scan for the strongest base station signal strength and then send a brief signalling message to inform the base station infrastructure of its location, so that it can be paged if incoming calls arrive (location update). Also, while in idle mode, the mobile station receives broadcast messages from the base station on the Broadcast Control Channel (BCCH) containing a list of neighbour cells (BA list) programmed in by the Network Operator. The mobile station periodically scans the neighbour cells to determine whether any of the received signal strengths from them is stronger than the one it has selected. It is important to note that the mobile scans for no cells other than those in the last received BA list, unless it loses communication with its selected base station.

When in active communication either in a call or exchanging signalling messages, such as while performing a location update, the mobile station receives the same neighbour cell information (BA list) on the Slow Associated Control Channel (SACCH) rather than the Broadcast Control Channel. The SACCH is directly associated with the channel (frequency and timeslot) on which the mobile station and base station are communicating.

In a multilayer cellular network (e.g. an area covered by a macrocell overlay and a microcell underlay as shown in FIG. 1) the network planner will normally have designed the signal strengths from one layer to be

greater than for the other layer (usually microcells would be the stronger). All mobile stations will select this layer and scan its designated neighbours.

Selected mobiles (e.g. those detected as being fast moving) can be directed from the stronger microcell layer to the weaker layer macrocell layer by invoking communication with the mobile station either on a traffic channel or a control channel as reference in UK Patent Application by same applicant CE30092P (e.g. Location Update Method claimed by Crichton et al.) and then performing a handover. However, once sent to the weaker layer, they will immediately drop back to the stronger layer through the normal idle mode scanning procedure.

A preferred embodiment of the present invention as shown in FIG. 2 describes a method of holding a selected mobile station on a weaker layer or the above described macrocell layer.

In step 20, the mobile station 19 is receiving service from microcell 11 and receiving a neighbour list including the surrounding microcell base stations as well as possibly the neighbouring macrocells including the macrocell 1 that the mobile station 19 is also currently located in.

In step 22, the network requires the mobile station to handover from the microcell layer, microcell 11, to the macrocell layer, macrocell 1, by any handover decision method including the one described in UK Patent Application by the same applicant (CE30092P). However, it is contemplated by the present invention that a mobile station may also have the capability and proper information to decide to handover from the microcell layer to the macrocell layer.

In step 24, when the microcell layer base station is in the process of handing over the selected mobile station 19 to macrocell 1 of the macrocell layer, instead of sending the normal BA list (which would normally be the same list as sent to all other mobile stations on the BCCH and other SACCH's), the base station sends a "false BA list" on the specific SACCH, only to the selected mobile station 19. This "false BA list" only contains base station channels in the weaker macrocell layer.

By doing this, the base station deletes scanning information on the microcells or the microcell layer from the mobile station memory. The network operator also arranges that microcell layer base stations do not appear in the BA lists sent on the BCCH's and SACCH's of the macrocell layer base stations. The mobile station 19 therefore does not scan for

microcell layer base stations and remains in the macrocell layer, as in steps 25-26.

The method above allows a selected mobile station to remain indefinitely in the macrocell layer once it is there, because no microcell layer base stations will appear in the neighbour lists.

However, it will often be desirable for certain mobiles to select microcell layer from the macrocell layer. An example may be where pedestrian hand portables move through a macrocell region before arriving in the microcell region to which they should preferably be assigned.

FIG. 3 shows an alternative embodiment of the present invention that allows a mobile station 18 to return to a microcell 11 in the microcell layer.

In step 32 the mobile station 18 is being serviced by macrocell 1. If it is determined, as in step 34, that the macrocell layer base station is co-ordinated with the microcell layer (i.e. it is controlled from the same Base Station Controller, or a co-operating or co-ordinated one) then a similar method can be employed. The selected macrocell layer base station communicates with the selected mobile station 18 and sends a "false BA list" which unlike its normal BA lists, contains base station frequencies in the microcell layer. This specific mobile station will then scan for base stations in both the macrocell layer and the microcell layer, and if a microcell layer base station is indeed stronger, it will select it, as in step 36.

If the macrocell layer is not co-ordinated by the microcell layer then the network operator arranges to periodically have the macrocell base station briefly send out a special or modified BA list, as in step 38, which unlike the normal ones, contains the microcell layer frequencies (e.g. periodically send this "modified BA list" for say 20 seconds every 5 to 30 minutes).

Mobile station 18 will then scan for the microcell layer at these times, and can be retained on the microcell layer once they have selected it as in steps 39 and 40.

If necessary, the mobile station can be returned to the macrocell layer or remain on the macrocell layer, in step 32 or according to the method of FIG. 2 above.

Although, the above description is in terms of microcell layers and macrocell layers any type of cell may be combined or considered in the different layers.

According to the present invention, a method is provided where a handover is performed for a mobile station from a microcell to a macrocell in a multicellular environment where the mobile station will select and stay on the layer that is desired. For example, fast moving mobile stations will pass through a macrocell before they see the "modified BA" list including the microcells, so they will never scan for the microcells. Pedestrian hand portables will remain on their selected macrocell base station long enough for them to see the "modified BA list" and hence will eventually seek the microcell network.

The present invention provides a method of efficiently performing handovers including allowing mobile stations to stay on desired cell layer in multicellular environments.

Claims

1. A method of performing a handover for a mobile station in a multicellular environment having at least one macrocell wherein at least partially disposed in the at least one macrocell is a plurality of microcells, each cell includes a base station, the method comprising the steps of:

determining to handover from one of the plurality of microcells to the macrocell;

performing handover from the one of the plurality of microcells to the macrocell; and

sending a false neighbour list to the mobile station.

2. A method of performing a handover for a mobile station in a multicellular environment having at least one overlay layer including a plurality of macrocells and an underlay layer including a plurality of microcells, the underlay layer is at least partially disposed within the overlay layer, each cell includes a base station, the method comprising the steps of:

a) determining to handover from one of the layers to the other layer;

b) performing handover from the one of the layers to the other layer; and

c) sending a neighbour list to the mobile station wherein the neighbour list contains only cells associated with the layer that the mobile station was handed over to in step b).

3. The method of any of the preceding claims further comprising periodically broadcasting a modified neighbour list that includes cells that are associated with the layer that the mobile station is not currently receiving service from.

4. A method of determining a handover for a mobile station in a multicellular environment substantially as herein described with reference to FIGS. 2-3 of the drawing.

**Patents Act 1977**
**Examiner's report to the Comptroller under Section 17**
**(The Search report)**

Application number
GB 9420002.9

**Relevant Technical Fields**

(i) UK Cl (Ed.M) H4K KY4D8, KY4D14H, KY4D14Q; H4L LDSD, LDSX

(ii) Int Cl (Ed.5) H04Q 7/04

Search Examiner
MR M J BILLING

Date of completion of Search
24 NOVEMBER 1994

**Databases** (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASES: WPI

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1 to 3

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

| Category | Identity of document and relevant passages | | Relevant to claim(s) |
|---|---|---|---|
| A | GB 2242806 A | (STC) page 3 paragraph 2 | 1,2 |
| A | EP 0589279 A2 | (SIEMENS) Abstract | 1,2 |
| A | WO 93/19560 A1 | (MOTOROLA) page 6 line 36 to page 9 line 9 | 1,2 |

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